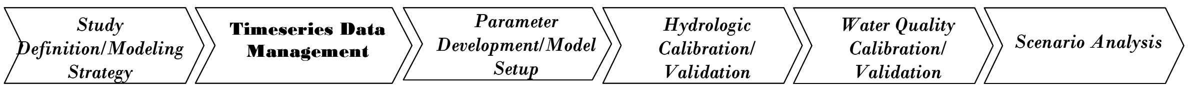
Exercise 3 - WDM Utility

BASINS/HSPF Application Steps



In order to successfully apply WinHSPF, meteorological data local to the area being studied are required. The current version of BASINS contains an average of 10 meteorological stations per state. These data are stored in the Watershed Data Management (WDM) format, which is used by both BASINS and HSPF. WDM files and the code library that manages them provide a powerful tool for managing and manipulating time-series data. However, to create and work with a WDM file requires a significant level of user education. BASINS users are greatly benefited by having a straightforward, easy-to-use tool that enables them to build and update WDM meteorological files without learning the detailed logistics of WDM operations. This tool is WDMUtil.

The WDMUtil program provides operational capabilities to allow users to import available meteorological data into WDM files and perform operations necessary (e.g., editing, aggregation/disaggregation, filling missing data, etc.) in order to create the input time-series data for WinHSPF. WDMUtil will allow the user to add available local meteorological data to their study, thus removing the existing reliance on the limited set of meteorological data stored in BASINS (USEPA, 1999).

Questions answered in this exercise:

1) How do I create a new WDM file to hold my local weather data?
2) How do I import local weather data using WDMUtil import scripts?
3) How do I import local weather data using WDMUtil by creating an import script?
4) How do I use the Compute/Disaggregate time series tool?

A. Creating a new WDM file with local weather data

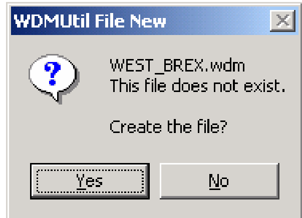
QUESTION ANSWERED:
1) How do I create a new WDM file so I can import local weather data?

1. From the **Start** menu under **Programs,** select **Basins** and then **WDMUtil**.

2. From the **File** menu, select **New**.

3. Type "WEST_BREX" as the file name.

4. Click OPEN. The following message will appear:



5. Click YES.

Note: We just created a blank **.wdm* file open into which we will import West Branch Patuxent weather data. Because of time constraints, we will not be importing all required time series; however, we will discuss the basics required to import all data types.

Note: HSPF requires a unique data set for each meteorological parameter that will be imported. In the BASINS Met WDM files, 20 data set fields relating to specific meteorological parameters are allocated for each WDM station. Using WDMUtil, data sets in WDM files are designated by a unique number and other relevant information relating to the time series data fields into which the data are imported. The following table displays data sets and a brief description of the information contained in each data set for a template WDM file used to import both hourly and daily data sets for 10 WDM stations. Data sets are numbered from 11 to 210. Notice that all hourly information is listed in data fields 1 through 8. HSPF algorithms use these hourly values. The remaining data fields (9 - 16) contain daily time series data, as well as intermediate time series data used in the conversion of HSPF parameters (USEPA, 1998). This data set numbering scheme in WDM files is not required, but is presented as a systematic approach to organizing your weather data timeseries.

Table 1. Data Set Numbers to be used within WDMUtil

Data set Fields	Data set	Data set Numbers	Description Parameter
1	PREC	(11,31,51,…191)	hourly precipitation
2	EVAP	(12,32,52,…192)	hourly evaporation
3	ATEM	(13,33,53,…193)	hourly temperature
4	WIND	(14,34,54,…194)	hourly windspeed
5	SOLR	(15,35,55,…195)	hourly solar radiation
6	PEVT	(16,36,56,…196)	hourly potential evapotranspiration
7	DEWP	(17,37,57,…197)	hourly dewpoint temperature
8	CLOU	(18,38,58,…198)	hourly cloud cover
9	TMAX	(19,39,59,…199)	daily maximum temperature (optional)
10	TMIN	(20,40,60,…200)	daily minimum temperature (optional)
11	DWND	(21,41,61,…201)	daily windspeed (optional)
12	DCLO	(22,42,62,…202)	daily cloud cover (optional)
13	DPTP	(23,43,63,…203)	daily dewpoint temperature (optional)
14	DSOL	(24,44,64,…204)	daily solar radiation (optional)
15	DEVT	(25,45,65,…205)	daily evapotranspiration (optional)
16	DEVP	(26,46,66,…206)	daily evaporation (optional)
17		(27,47,67,…207)	Empty
18		(28,48,68,…208)	Empty
19		(29,49,69,…209)	Empty
20		(30,50,70,…210)	Empty

Note: In order to learn how to import data into the WDMUtil, we will enter a few different data sets. First we will import the hourly precipitation that is available through NOAA.

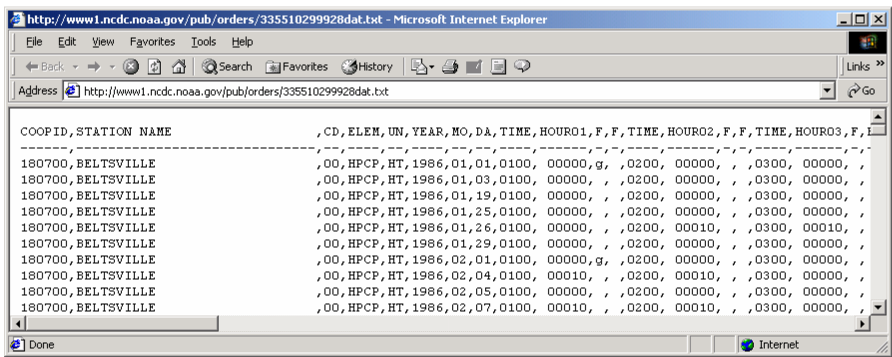
B. Importing local weather data into the WDMUtil

QUESTION ANSWERED:
2) How do I import local weather data using WDMUtil import scripts?

Generally, you would begin this exercise by downloading some precipitation data from the National Climatic Data Center (NCDC) for a weather station in the West Branch Patuxent area. However, there is a charge for the data, so the file is provided in the folder *c:\basins\extra training files*. To download the data, you would:

- Go to www.ncdc.noaa.gov/.
- Click "DATA & Products" in the left hand column.
- Click "Hourly Precipitation Data (TD 3240)" and click the appropriate link that follows.
- Make sure that you are on the NNDC Climate Data Online page. In the "Retrieve data for:" section, click the radio button next to "Country" and select "United States" from the drop down menu.
- Click CONTINUE.
- In the "Retrieve data for:" section, select "Maryland" from the "Or select a State/Province" drop down menu

- Click CONTINUE.
- Click on “BELTSVILLE” in the “Select Maryland Stations” box.
- Select CONTINUE.
- In the Select Date Restrictions frame, enter 1/1/1986 and 12/31/1988 in the “From” and “To” boxes, respectively. Change the “Output Format” to “Delimited, with Station Name” and check that the “Output Format Delimiter” is “Comma.”
- Click CONTINUE.
- Click the box next to the “Inventory Review:” notice. Enter your email address at the bottom of this page and click SUBMIT REQUEST. Within minutes, your request should be sent to you.
- Open your email account and find the message from NNDC.Weborder@noaa.gov or cdo@ncdc.noaa.gov. The message should contain 4 links. Click on the link that ends with *dat.txt*. This is the data file and it should look like the following:



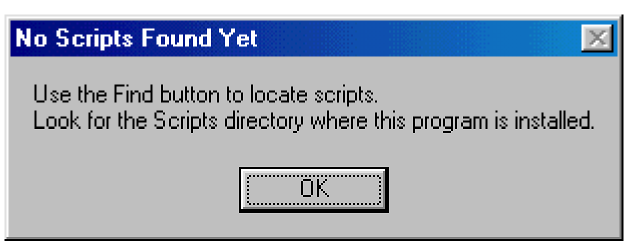
- From the **File** menu, select **Save As**.
- Name the file “*beltsville_precip*.” Make sure that “Text File” (*.txt*) is selected in the “Save As Type” box and click SAVE.
- Close the web browser.

1. From the **File** menu in WDMUtil, select **Import**.

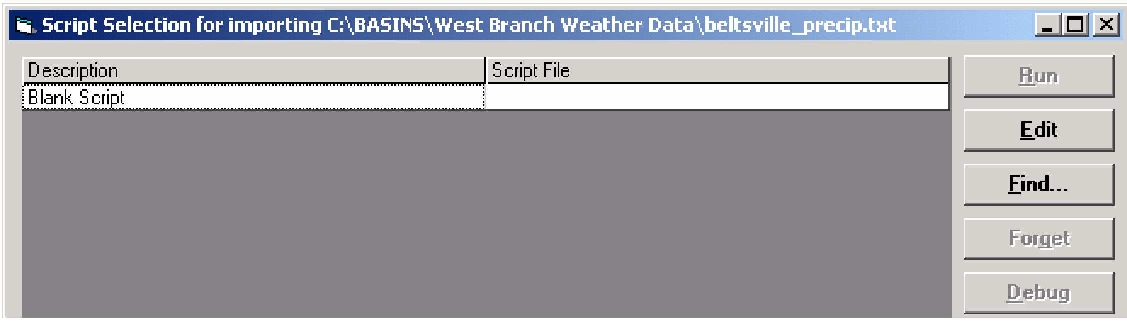
2. Navigate to *c:\Basins\Extra Training Files.*

3. Select “*beltsville_precip.txt*” and click OPEN.

4. Click OK if the following “No Scripts Found Yet” message box appears.



The following “Script Selection for Importing” window will appear:

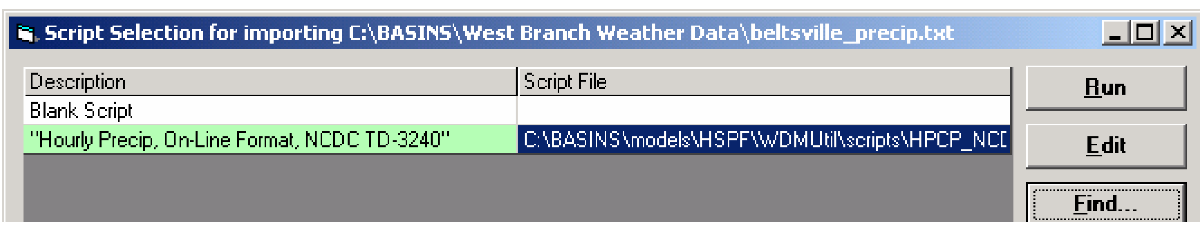


5. Click FIND.

6. In the “Open Script File” window, navigate to *c:\basins\models\Hspf\WDMUtil\scripts.*

7. Select “*HPCP_NCDC_OL.ws*” and click OPEN.

8. Select “Hourly Precip, On-Line Format, NCDC TD-3240.” The *c:\BASINS\models\HSPF\WDMUtil…* record will become highlighted in green (left) and blue (right).



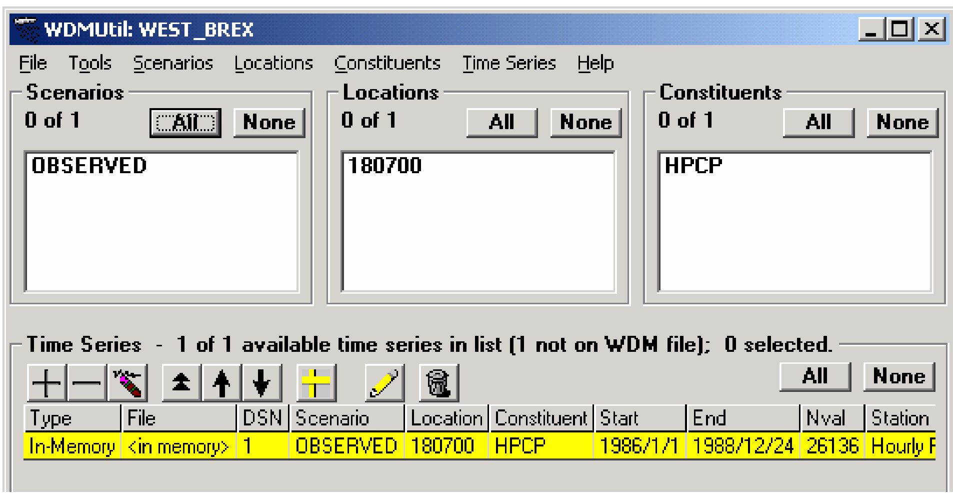
Note: The following table summarizes the data import scripts distributed with WDMUtil. Sample data files listed in the table are also distributed. (Hummel et al., 2001).

Script File Name	Description of Data Format Script Reads	Sample Data File
HPCP_NCDC_Arch.ws	Hourly Precip, Archive Format, TD-3240	Ithaca_prec.ncd, ncdc.ncd
HPCP_NCDC_OL.ws	Hourly Precip, On-Line Format, NCDC TD-3240	aberdeen.ncd
IdStMet_DLY.ws	Idaho State Climate Services Daily Format	fennrs.log
MultiCol7_Wid10_Mon.ws	Multi-Columns (7) of Width 10, Monthly Values	acpoint.prn
SimpDly_MDY.ws	Simple Daily Value Format-mm/dd/yyyy	usgsfecal.prn
SimpDly_YMD.ws	Simple Daily Value Format-yyyy/mm/dd	
SimpHrly_YMDH.ws	txtScriptDesc	
SOD_OL.ws	Summary of the Day TD-3210	Bing_SOD.ncd

Script File Name	Description of Data Format Script Reads	Sample Data File
SOD_OL_Coop.ws	Summary of the Day, On-Line, Coop	Amherst.ncd
SurfAir_Hrly_Arch.ws	Surface Airways Hourly Data, Archive Format, TD-3280	surface.ncd
UsgsDvWeb_MDY.WS	USGS Daily Web Values (mm/dd/yyyy)	hist_littleyellow.cgi
UsgsDvWeb_YMD.ws	USGS Daily Web Values (yyyy/mm/dd)	tendall.rdb
WDMUtil_Exp_Dly.ws	WDMUtil Export Format - Daily Values	tmax.exp
WDMUtil_Exp_Hrly.ws	WDMUtil Export Format - Hourly Values	prec.exp

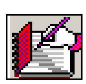
9. Click RUN.

Note: A new record will appear in the “Time Series” frame.

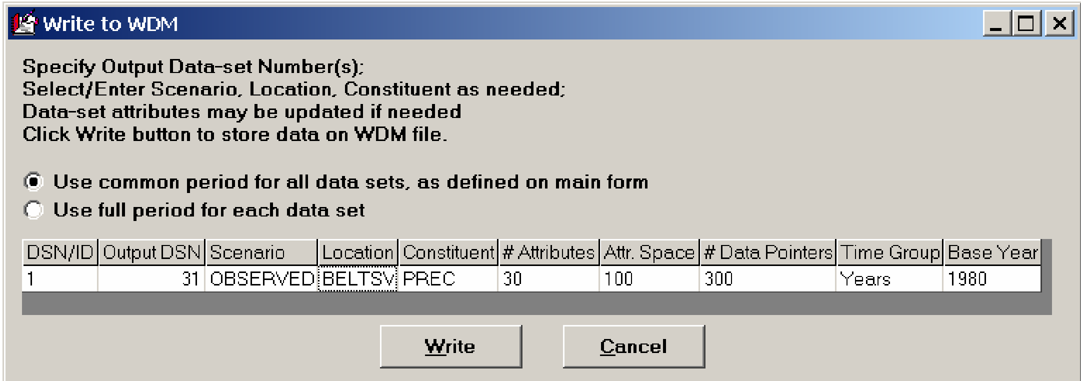


Note: Notice in the Type column of the Time Series frame that it says “In-Memory.” This means that the data was read in, but it has not been written to the WDM. We will need to write it to the WDM (this is similar to saving a file).

10. In the “Time Series” frame, click the newly added time series. It will turn blue.

11. In the “Tools” frame, click  (Write Time Series to WDM).

12. In the “Write to WDM” box, enter 31 as the Output DSN, change the constituent name to “PREC”, and change the location name to “BELTSVILLE.”



Note: Notice that the four-letter abbreviation we used in the "Constituent" box is the abbreviation given in Table 1 on page 2. The name entered in the "Location" box must be **EXACTLY** the same each time you import/open a new data set into this wdm. For example, if you called the precipitation data location "BELTSVILLE" and then you called the hourly evaporation data location "Beltsville," they will be treated as two different locations in WDMUtil.

13. Click WRITE. The following message will appear:

14. Click OK.

Note: The new time series is no longer highlighted and the "Type" is now WDM.

Before we learn how to use other tools in the WDMUtil, we will learn how to import other types of data. In the following section, we will create our own import script to import time series data that were gathered from different locations (Marlboro, Maryland, and West Branch Patuxent).

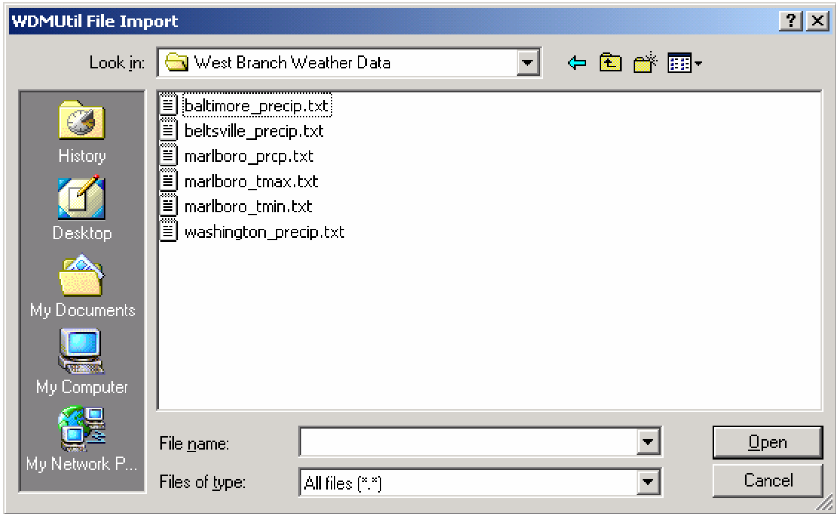
C. Creating an Import Script

QUESTION ANSWERED:
3) How do I import local weather data using WDMUtil by creating an import script?

1. From the **File** menu, select **Import**.

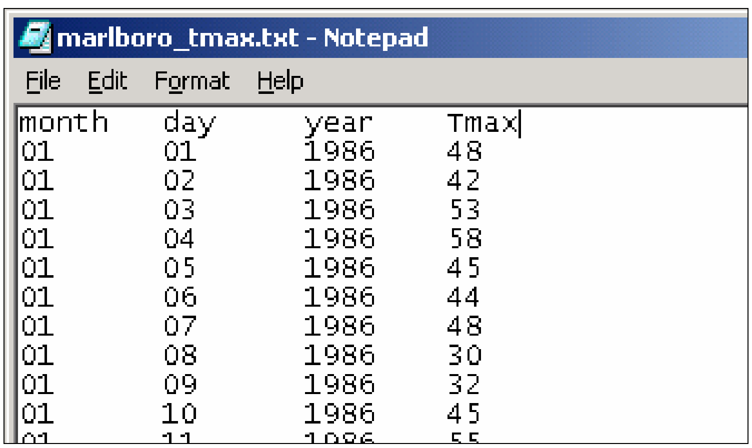
2. Navigate to *c:\basins\West Branch Weather Data*.

3. From the **"**Files of type:" menu, select "All Files (*.*)" and select "*marlboro_tmax*."

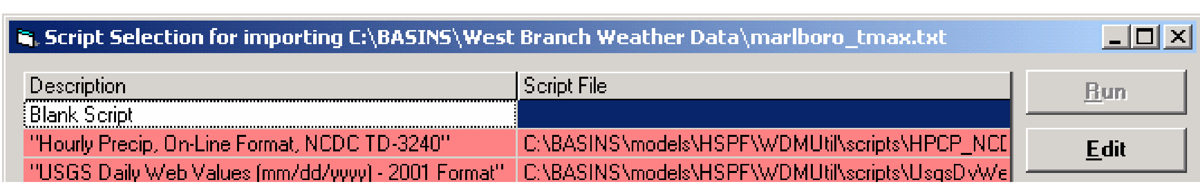


4. Click OPEN.

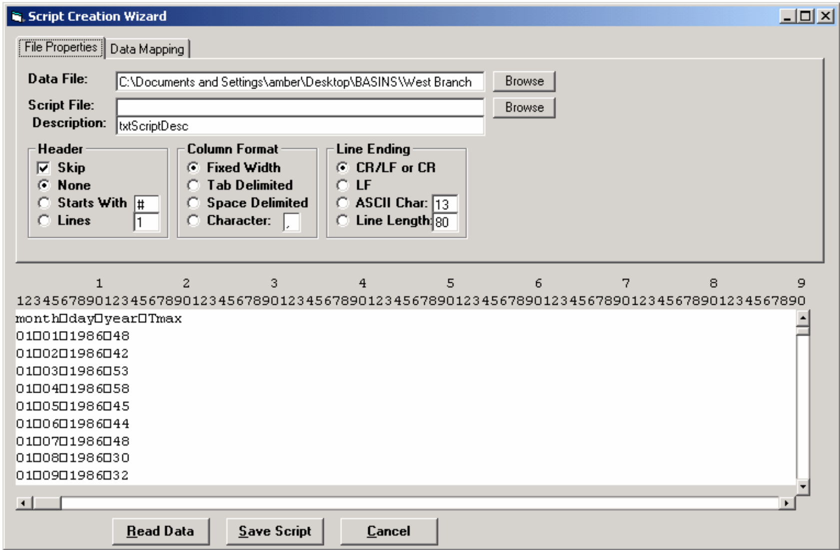
To illustrate how you can create an import script, we will import daily maximum temperature data for the Upper Marlboro watershed. There are currently no import scripts available for this format (shown below), so we will create one.



5. In the “Description” column, click the “Blank Script” box. The corresponding “Script File” box will turn blue.



6. Click **EDIT**. Notice that a sample of the data you are importing is shown in the bottom portion of the window.



7. In the “Header” frame, click the button beside “Lines.”

8. Enter “1” in the box beside “Lines.”

   Note: This specifies that we have one line of headings in the file we are importing. Notice that the header line is no longer visible in the data window.

9. In the “Column Format” frame, make sure the “Fixed Width” button has been selected.

   Note: This particular file is actually tab-delimited, but we are using the fixed width option to help you understand how this option works.

10. In the “Line Ending” frame, make sure that either the CR/LF or the CR button has been selected.

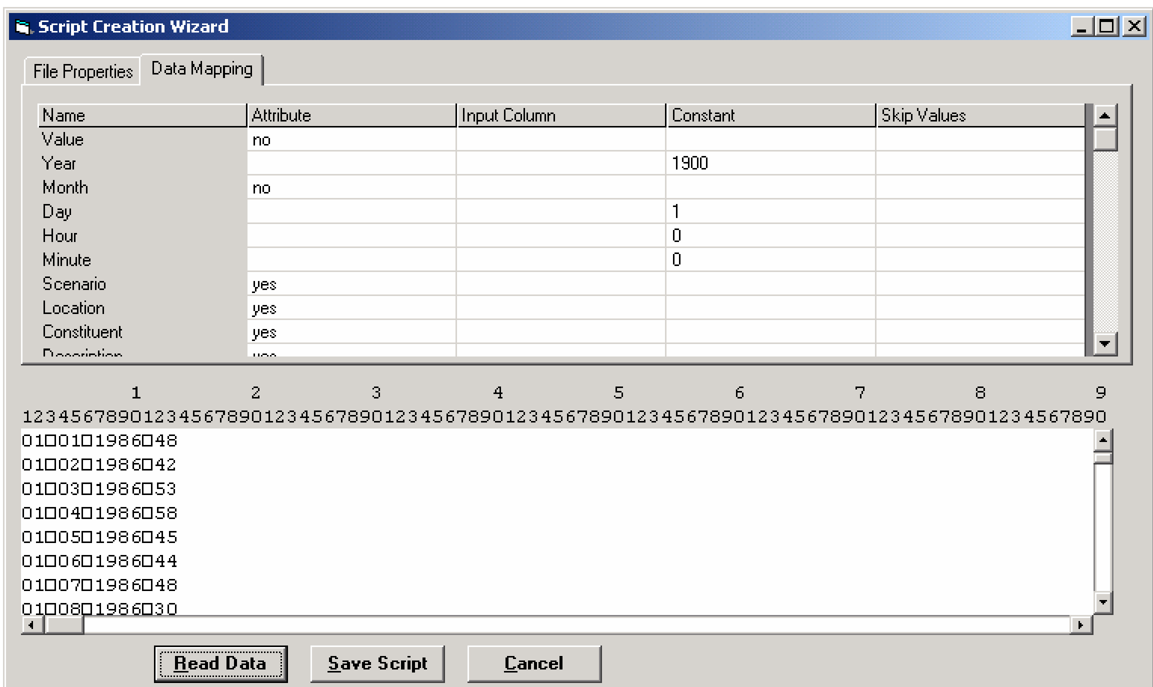
    Note:
    - CR = Carriage Return
    - LF = Line Feed

11. Click the “Data Mapping” tab.
    Note: The “Data Mapping” window requires user-specification of the data. The list at the top of the “Data Mapping” tab contains *Name*s of various data elements used in importing data. The lower portion of the tab contains a display of the data file with column numbers across the top of it. These column numbers can be highlighted (by clicking and dragging with the mouse) to define the location of the data elements. Thus, to define the *Input Column* for a data element, click on that element and then click and drag on the column numbers in which the element is found. In some cases a data element’s value will be constant (e.g., *Hour* and *Minute* for daily data). In such a case, the value for that element may be entered under the *Constant* column. The *Constant* column may also be used to apply a constant value to a data element. This is

done by inserting the desired mathematical symbol in front of the constant value. For example, if the year values on a file were only the last two digits, entering *+1900* in the *Constant* column would add 1900 to the 2-digit year values when processing the data.

Some data elements are general information about the data being processed. These elements may be stored as attributes of the time series. To indicate a data element as an attribute, a *yes* is entered under the *Attribute* column for that element. The values for these attributes may then be entered under the *Constant* column. It is important to enter values for the *Scenario*, *Location*, and *Constituent* attributes since this will make the new time series more recognizable by WDMUtil and other BASINS components.

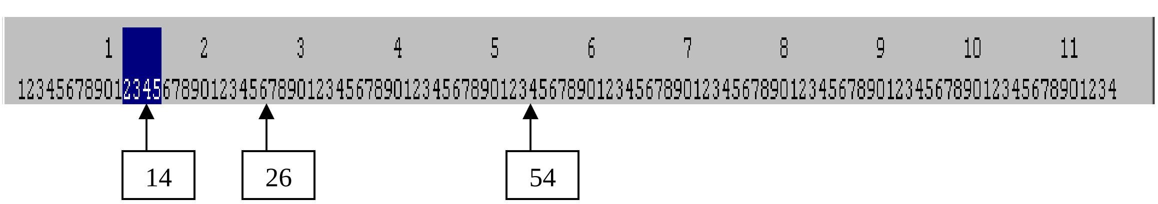
Once the data elements have been defined as desired, SAVE SCRIPT may be used to write the script to a file for future use. READ DATA is used to try to process the data using the script defined in the wizard. CANCEL will close the Wizard and no data will be imported (Hummel et al., 2001).

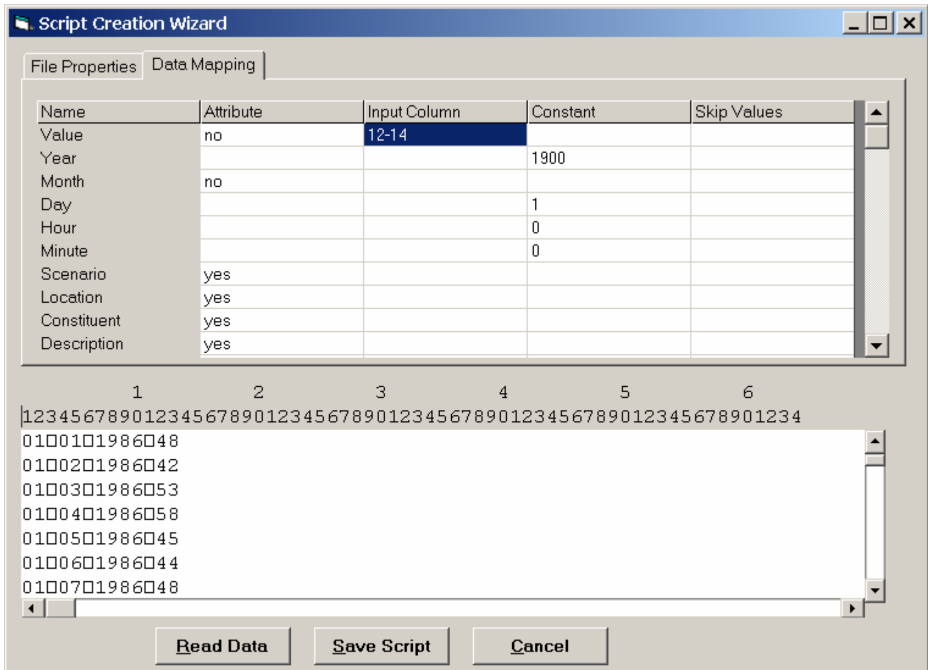


12. Click in the cell that corresponds with the "Input Column" and the "Value" row.

13. In the lower portion of the tab, highlight columns 12-14 by clicking and dragging with the mouse, to define the location of the data elements. Notice 12-14 show up in the cell selected earlier.

Note: The columns are numbered using the following schematic:





14. Click in the cell corresponding to “Input Column” and “Year.”

15. Highlight columns 7-10 by clicking and dragging with the mouse.

16. Click in the cell that corresponds with the “Input Column” column and the “Month” row.

17. Highlight columns 1-2 by clicking and dragging with the mouse.

18. Click in the cell that corresponds with the “Input Column” column and the “Day” row.

19. Highlight columns 4-5 by clicking and dragging with the mouse.

20. In the cell that corresponds with the “Constant” column and “Hour” row, enter “24”.

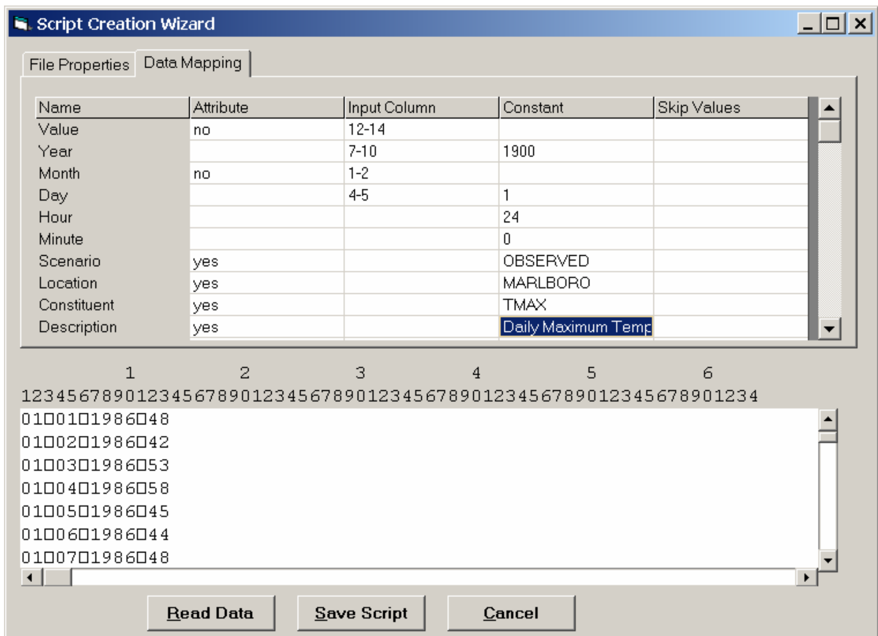
Note: The “Hour” represents the hour the observations were made. To understand the importance the “Hour” being set correctly, let’s consider daily precipitation values. If the observation were made at 8:00 am on 1/2/1985, the value would represent the precipitation that occurred during the previous 24-hour period, from 8 am on 1/1/1985 to 8 am on 1/2/1985. In the case of this exercise, it is assumed that daily maximum temperatures, daily minimum temperatures, and daily precipitation values were recorded at hour 24 (at the very end of the day) and therefore, represents data collected from midnight to midnight on the date corresponding to the daily value. Observation times can generally be obtained from the source of the data.

21. In the cell that corresponds with the “Constant” column and “Scenario” row, enter “OBSERVED” (in capitals).

22. In the cell that corresponds with the "Constant" column and "Location" row, enter "MARLBORO" (in capitals).

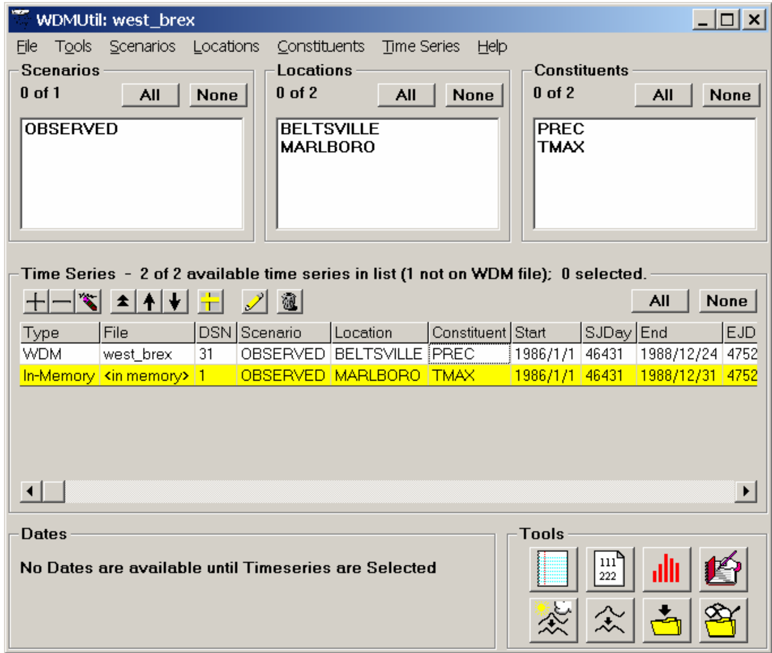
23. In the cell that corresponds with the "Constant" column and "Constituent" row, enter "TMAX."

24. In the cell that corresponds with the "Constant" column and "Description" row, enter "Daily Maximum Temperature." Your window should now look like the following.



25. Click READ DATA.

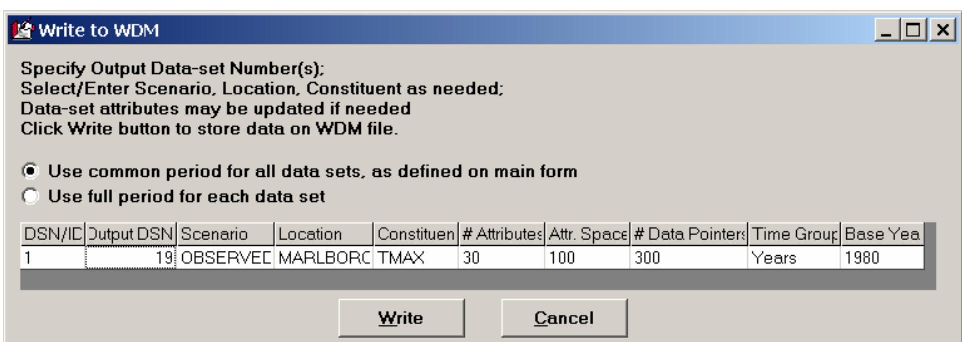
Note: Your screen should look like the following. Notice that there is another yellow time series that is in memory.



26. The new record must be written to the WDM. In the "Time Series" frame, click on the newly added time series. It will turn blue.

27. In the Tools frame, click  (Write Time Series to WDM).

28. In the "Write to WDM" box, enter 19 as the Output DSN.



Note: The number "19" came from Table 1 on page 2 of this exercise. Again, in order to be able to use this WDM within BASINS and WinHSPF, you must follow the given naming and numbering scheme.

Note: DSN = Data Set Number

29. Click WRITE.

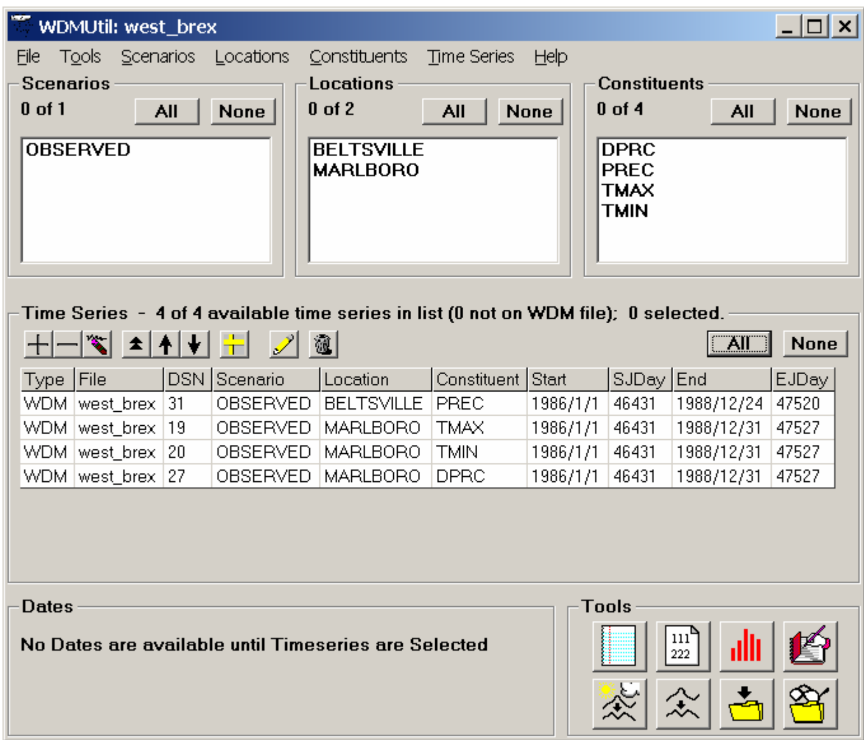
30. Click OK when a message appears telling you that the data set was successfully stored.

Note: The new time series is no longer highlighted and the "Type" is now WDM.

31. Follow steps 1-29 (in Section C) to import additional local data files "*marlboro_tmin.txt*" and "*marlboro_precip.txt*." Use "OBSERVED" as the scenario and "MARLBORO" as the location for each file. Use the following, from Table 1, as the constituent names and DSNs when creating scripts and writing to the WDM.

File	Constituent	Description	DSN
marlboro_tmin.txt	TMIN	Daily Minimum Temperature	20
marlboro_precip.txt	DPRC	Daily Precipitation	27

After these files are entered, the WDMUtil window should look like the following:

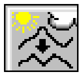


We will use the above time series to calculate additional time series data using "Tools" within WDMUtil.

D. Computing and disaggregating data in WDMUtil

QUESTION ANSWERED:
4.) How do I use the Compute/Disaggregate time series tool?

In this section, we will use the imported minimum temperature and maximum temperature to compute a time series for daily potential evapotranspiration. That time series can then be disaggregated into hourly potential evapotranspiration.

1. Click  (Compute/Disaggregate Meteorological Time Series tool), or from the **Tools** menu, select **Compute**.

2. In the “Operation” frame, make sure the button beside “Compute” has been selected.

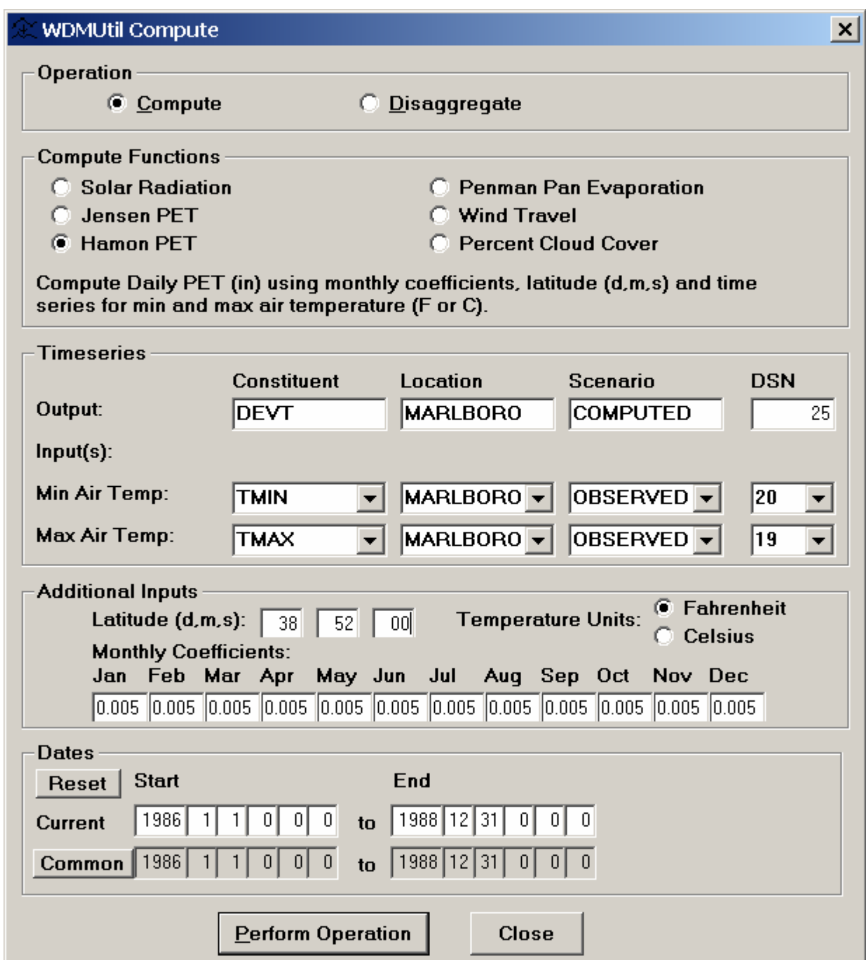
3. In the “Compute Functions” frame, select the button beside “Hamon PET.”

4. In the “Timeseries” box, the “Output” section should already be filled in with the appropriate constituent abbreviation, location, and scenario. Enter 25 in the DSN textbox.

   Note: As mentioned previously, the DSN corresponding to DEVT can be found in the Table 1.

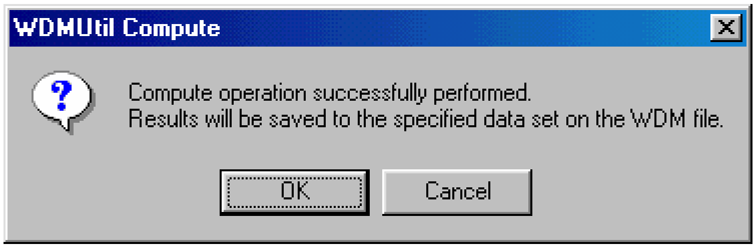
5. In the “Additional Inputs” frame, enter the “Latitude” as 38, 52, and 00 and check that the “Fahrenheit” button is selected.

   Your screen should look like the following:

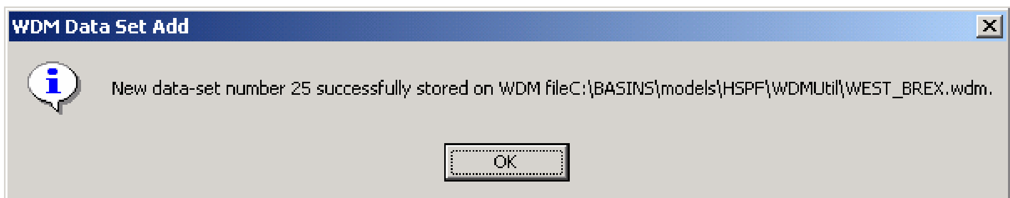


6. Click PERFORM OPERATION.

7. Click OK when a message opens informing you that the compute operation was successfully performed.



8. Click OK when a message appears informing you that the new data set number was successfully stored.



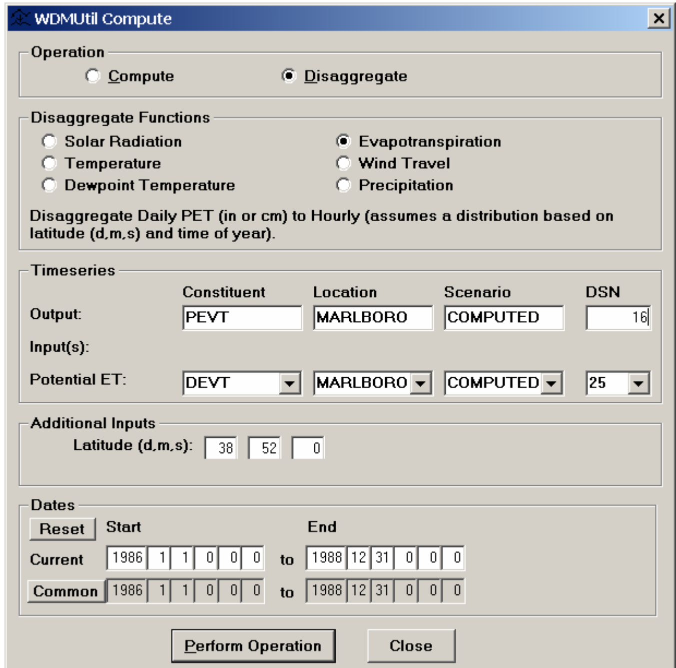
Note: Now that we have computed the daily Potential Evapotranspiration, we need to disaggregate it into hourly.

9. In the “Operation” frame, click the button beside “Disaggregate.”

10. In the “Disaggregate Functions” box, select the button beside “Evapotranspiration.”

11. We will need to look at our table and look up the corresponding DSN for PEVT. Enter 16 in the “DSN” text box.

12. In the “Additional Inputs” box, check that the “Latitude” is 38, 52, and 0.



13. Click PERFORM OPERATION.

14. Click OK on both of the subsequent screens.

15. Click CLOSE in the “WDMUtil Compute” window.

Another powerful function of WDMUtil is the ability to disaggregate daily precipitation into hourly values based on hourly time series from nearby stations. WDMUtil uses values from the secondary hourly station with daily total closest to the daily value of the station in question. If there is not a daily total from a secondary station within a user-specified tolerance of the daily value, hourly values are obtained from a triangular distribution of the daily value with a peak at the middle of the day. (Hummel et al., 2001).

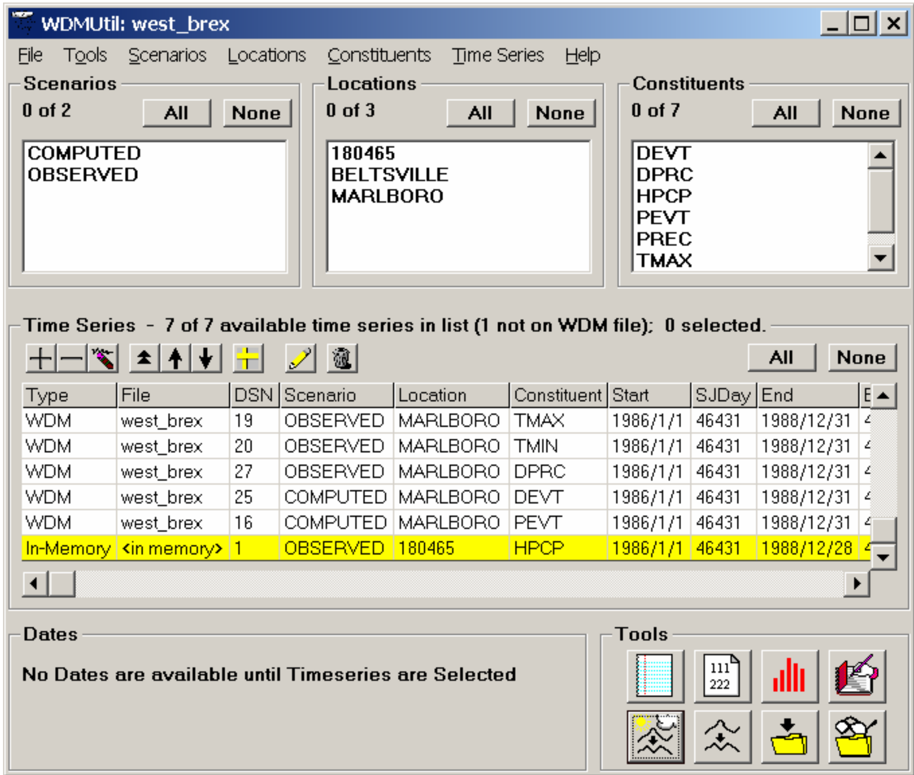
In this section, we will obtain hourly precipitation data for Marlboro. We already imported the Marlboro daily precipitation time series. We will use the Beltsville hourly precipitation data, which we imported earlier, along with hourly precipitation time series from two other nearby stations, Baltimore and Washington, as secondary station data. These data were previously downloaded from NCDC.

16. From the **File** menu select **Import.**

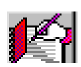
17. Navigate to *c:\basins\west branch weather data* and select “*baltimore_precip.txt.*” Click **Open**.

18. In the “Description” column, click the “Hourly Precip, On-Line Format, NCDC TD-3240” box. The corresponding “Script File” box will turn blue. Click RUN.

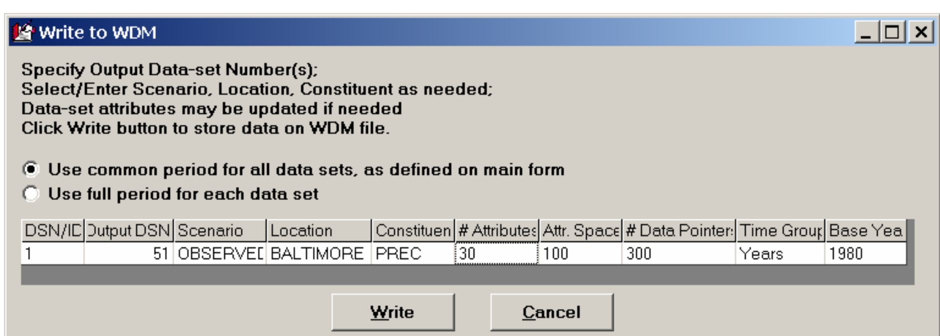
    Note: This is the same script we used to import the NCDC Beltsville Hourly Precipitation Data.



19. As with the Beltsville time series, this data set must be written to the WDM. In the “Time Series” frame, select the newly added time series. It will turn blue.

20. In the “Tools” frame, click  (Write Time Series to WDM).

21. In the “Write to WDM” box, enter 51 as the Output DSN, change the constituent name to “PREC”, and change the location name to “BALTIMORE.”

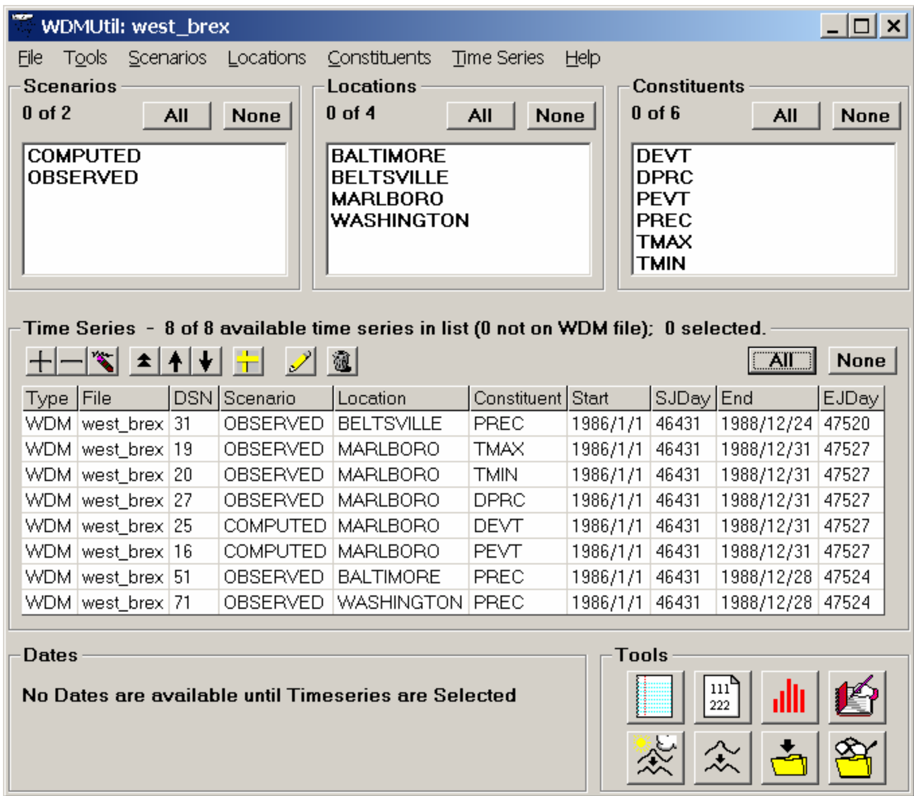


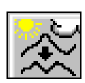
Note: Each time series must have a unique DSN. Although the constituent for this time series is the same as the Beltsville time series, we use a different DSN because it is a different location. This is done using the pattern on Table 1. For example, 11, 31, 51, 71 … are all acceptable DSNs for Hourly Precipitation, but are usually organized by location or source.

22. Click WRITE.

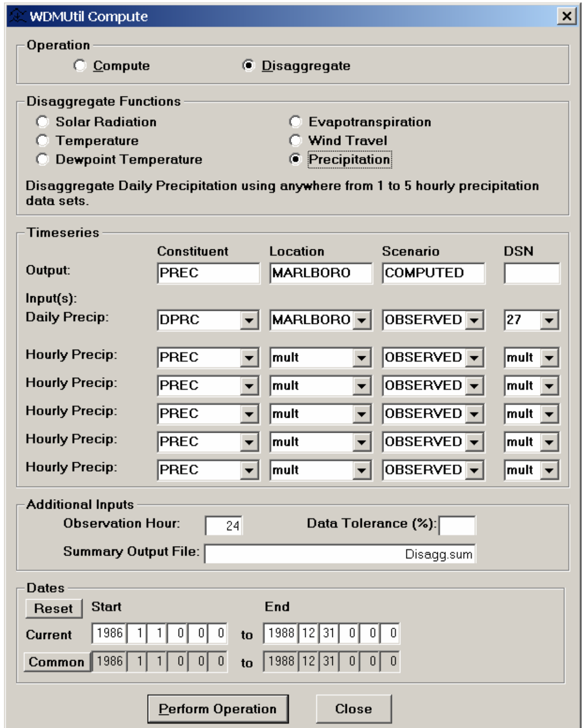
23. Click OK.

24. Follow steps 16-23 for "*washington_precip.txt*" using 71 as the Output DSN and "WASHINGTON" as the location name. The WDMUtil window should look like this:



25. In the "Tools" frame, click on  (Compute/Disaggregate Meteorological Time Series).

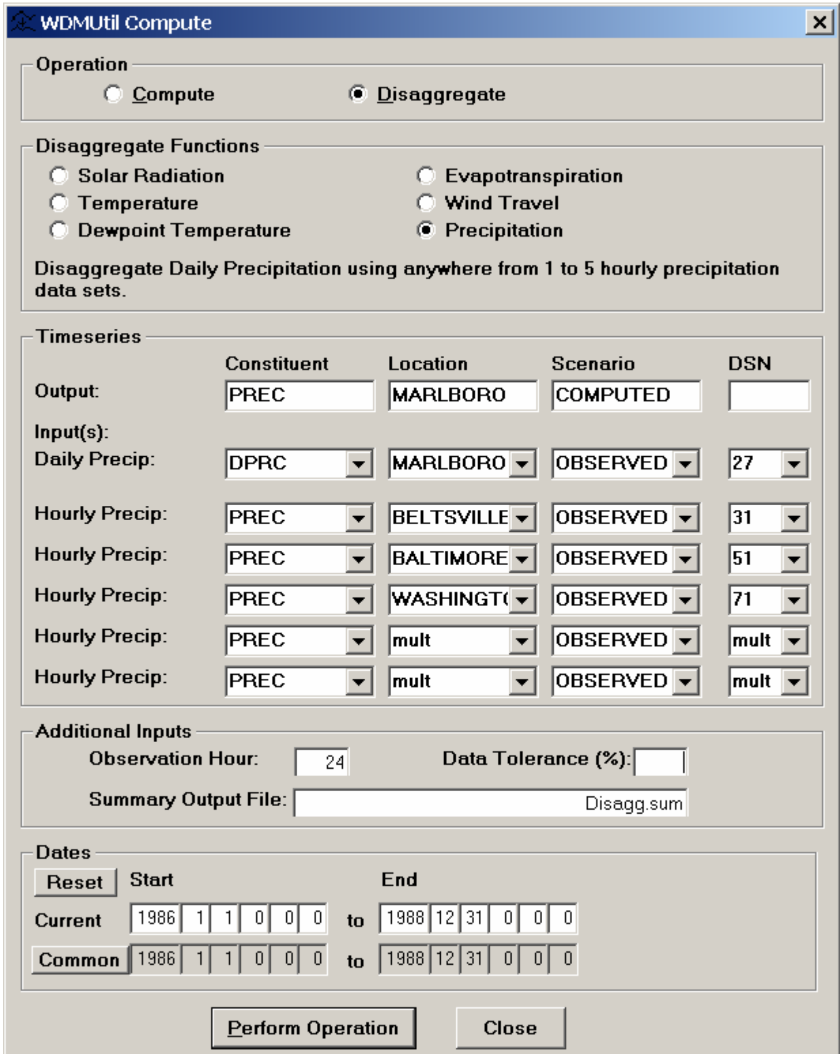
26. In the "Operation" frame, select the button beside "Disaggregate." In the "Disaggregate Functions" frame, select the button beside "Precipitation."



In the "Time Series" frame notice that the "Output" is specified as PREC (hourly precipitation) at Marlboro and that the daily precipitation input is specified as the Marlboro time series. The user must specify the hourly precipitation inputs.

27. In the first "Hourly Precip:" input row, select "BELTSVILLE" in the "Location" menu. Because there is only one time series associated with that location, no further specification is necessary.

28. In the second "Hourly Precip:" input row, select "BALTIMORE" as the location, and in the third row, select "WASHINGTON" as the location. The WDMUtil Compute window should look like the following:

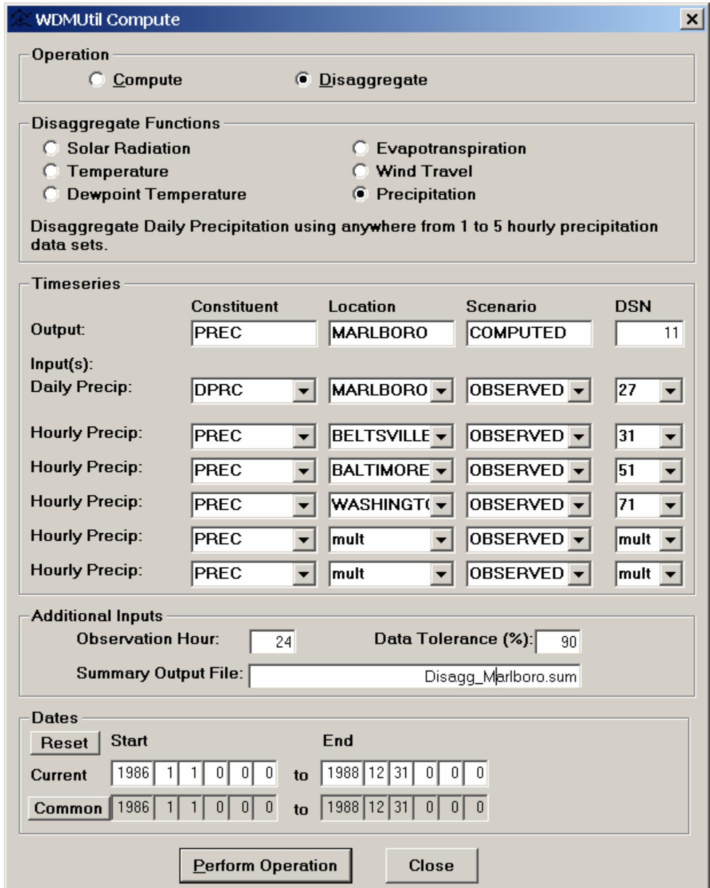


29. In the blank DSN box in the "Timeseries" frame, enter "11."

30. In the "Additional Inputs" frame, enter "90" in the Data Tolerance (%) box.

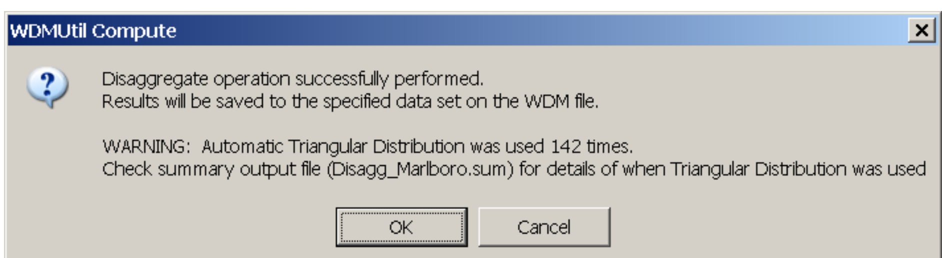
Note: As mentioned previously, WDMUtil uses a triangular distribution to disaggregate values outside of the data tolerance. Because triangular distribution is quite inaccurate, the data tolerance is set high in order to increase the acceptable range of daily totals and to minimize use of triangular distribution.

31. In the "Additional Inputs" frame, name the Summary Output File "*Disagg_Marlboro.sum*." This file can be examined to determine exactly which files were used when and when triangular distribution was employed. The WDMUtil Compute window should look like the following:

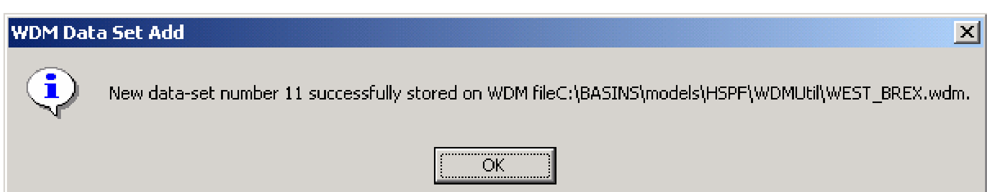


32. Click Perform Operation.

33. Click OK when the WDMUtil Compute window appears telling you that the disaggregation was successful. Notice that Triangular Distribution was used 142 times.

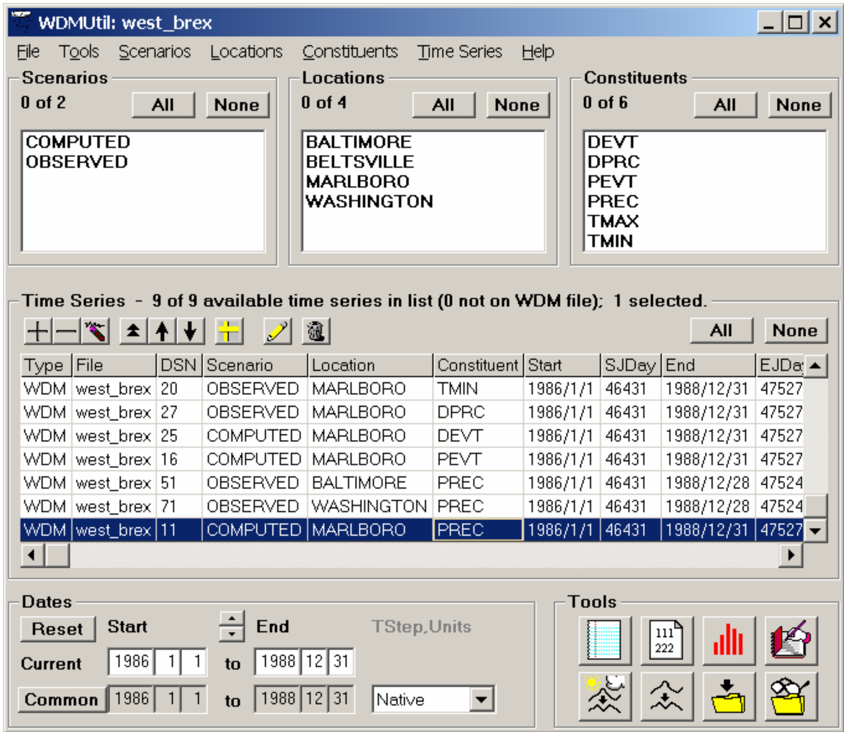


34. Click OK.



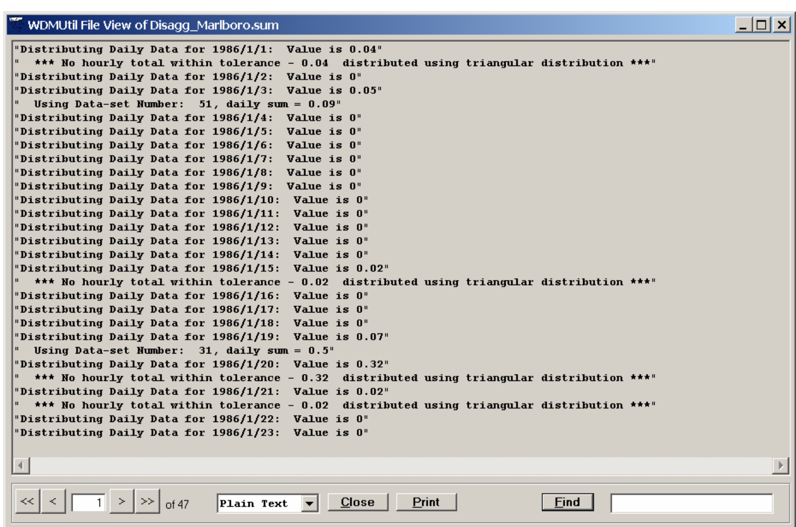
35. Click CLOSE in the "WDMUtil Compute" window.

Note: Notice the new time series in the "WDMUtil" window. If you wish, you can view this using the List/Edit tool.



36. In order to examine the disaggregation summary output file, click  (View a File) in the "Tools" frame.

37. Navigate to *c:\basins\West Branch Weather Data* and select "*Disagg_Marlboro.sum.*" Click OPEN.



Note: This file shows the occurrences of triangular distribution use, as well as which data set was used for hourly data on a given day.

38. Examine the file and click "Close" when done.

39. Close the WDMUtil window by clicking the "X" in the upper right hand corner.

Note: There are many other tools and functions within WDMUtil that could be addressed; however, due to time constraints, only the main tools necessary for creating a **.wdm* file with local data have been discussed in this exercise. Please refer to the WDMUtil Manual for further explanation.

References:

Hummel, P., J. Kittle, Jr., M. Gray. WDMUtil Version 2.0, A Tool for Managing Watershed Modeling Time-Series Data User's Manual, Contract No. 68-C-98-010, Work Assignment No. 2-05, Aqua Terra Consultants, Decatur, GA, 2001.

USEPA, Users Manual: Better Assessment Science Integrating Point and Nonpoint Sources: BASINS Version 2.0, EPA-823-B-98-006, U.S. Environmental Protection Agency, Washington, D.C., 1998.

USEPA, WDMUtil Version 1.0 (BETA), A Tool for Managing Watershed Modeling Time-Series Data User's Manual, EPA-823-C-99-001, U.S. Environmental Protection Agency, Washington, D.C., 1999.